

# Emerging Trends in Air Defense



# ***Kosovo...A War of Weather..Lessons Learned from JTF Noble Anvil***

We may own the night...but poor weather creates sanctuaries and operational lulls

- Precision-guided is no longer “good enough”
- We experienced greater than 50% cloud cover more than 70% of the time... and it wasn't the worst part of the year
- Laser or EO-guided munitions cannot hit what the pilots cannot see
- JDAM expenditure equaled the production rate

GPS-guidance is a requirement and the way ahead... *invest accordingly... allies too*

# **IADS Roll-Back..Kosovo**

## **Lessons Learned from JTF Noble Anvil**

After 78 days of hard campaigning, we effected little degradation on a modern IADS system

- Redundant systems and well-trained operators with the discipline to wait for a better opportunity
- Affected tactical employment of airpower throughout the war (altitude restrictions)
- Required significant ISR and SEAD efforts throughout the campaign (stressed LD/HD assets)

Will we train for this environment...or continue to assume we can take IADS down early?



# Serb Building Blocks of Counter-Targeting

**Movement**  
Use civilian vehicles and small numbers  
Use poor visibility

**Deception**  
False paints  
Decoys  
False transmission

**Information Warfare**  
Atrocities of US attacks  
False deployment of advanced systems  
Mention of chemical or bio weapons

**Concealment**  
Use ground features for concealment  
Use built-up areas and underground facilities

## To accomplish

- Deny NATO information dominance
- Preserve combat power
- Impede targeting of fixed sites
- Develop targeting methods

## An Asymmetrical Approach

“ We knew that NATO had modern techniques capable of detecting targets so we simply adapted to the conditions on the ground.” Serb Army General Negojav Nikolic

# Weapons Technology Trends:

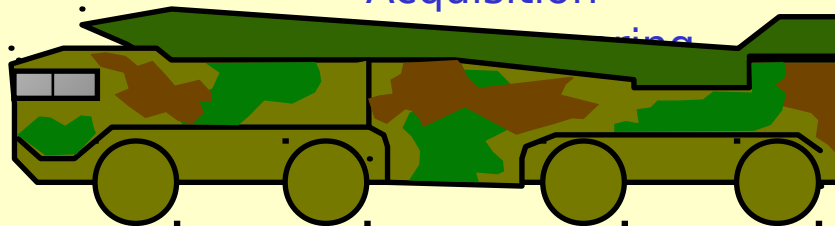
## SRBM

### Guidance & Control:

- Active Attitude Control System
- Inertial Guidance w/Terminal Digital Correlation
- On-board Digital Flight Computer

### Improved Warhead Options:

- Enhanced Blast
- NBC / Fuel Air Explosive
- Improved ICM
- Terminally Guided Homing
  - Subminitions
- Anti-radiation Homing
- On-board Target Acquisition



### Most Common

FROG-7 (RS)  
SCUD Variants  
SCUD-B (RS)  
Al Hussein (IZ)  
No-Dong (NK)  
SS-21 (RS)

### State of the Art

SS-21 (RS)  
SCUD-B (RS)

### Transporter Erector Launcher

- Survivability:
  - Low Observable Features
  - NBC protection
  - Lightweight armor
- Automated Fire Control
- SATCOM Digital Downlink: C3, GPS, TA, FD
- Shorter set-up time

### Accuracy & Range:

- Range:
  - Minimum 100 km
  - Maximum 1000 km
- CEP: 10m at min range  
≤ 100m at max range

### Propulsion

Solid Fuel

### Staging

Multiple Stages

# TBMs & Weapons of Mass Destruction

## EUROPE

Country	Chem	Nuc	TBMs
Belgium			Lance
France			Hades
Germany			Pluton Lance Scud SS-21 Frog - 7
Italy			Lance
Netherlands			Lance
UK			Lance
Former Yugoslavia			Frog - 7
Fmr Warsaw Pact (CZ,SL,HU,PL,RO,BU)			Scud Frog - 7

## FORMER SOVIET UNION

Country	Chem	Nuc	TBMs
Belarus			Scud
Kazakhstan			SS - 21
Russia			Frog - 7
Ukraine			
all others			

## AMERICAS

Country	Chem	Nuc	TBMs
Argentina			Alca
Brazil			ME / EE SS-300 / 1000

## CENTRAL ASIA

Country	Chem	Nuc	TBMs
Afghanistan			Scud
India			Agni Prithvi
Pakistan			Hatf I / II

## MIDDLE EAST

Country	Chem	Nuc	TBMs
Iran			Iran 130 Scud
Iraq			Al Abbas Al Hussein Condor 2 Scud Frog - 7 Lance Jericho I / II
Israel			
Saudi Arabia			
Yemen			Scud SS - 21 Frog - 7

## CA

Country	Chem	Nuc	TBMs
Canada			Badr Condor 2 Scud Frog - 7 Al Fatah SS-21 Scud Frog - 7
Africa			

## EAST ASIA

Country	Chem	Nuc	TBMs
China			M Family CSS - 1/2/4
North Korea			Scud Frog - 7 NHK - 1
South Korea			
Japan			
Philippines			
Thailand			
Malaysia			
Indonesia			
Green Island			Green Island Sky Hawk Scud SS-300



Theater Ballistic  
Missiles  
Confirmed programs:  
Chemical weapon  
program  
Nuclear weapon  
program  
**UNCLASSIFIED**  
Chemical or Nuclear

# Weapons Technology Trends:

## Aviation

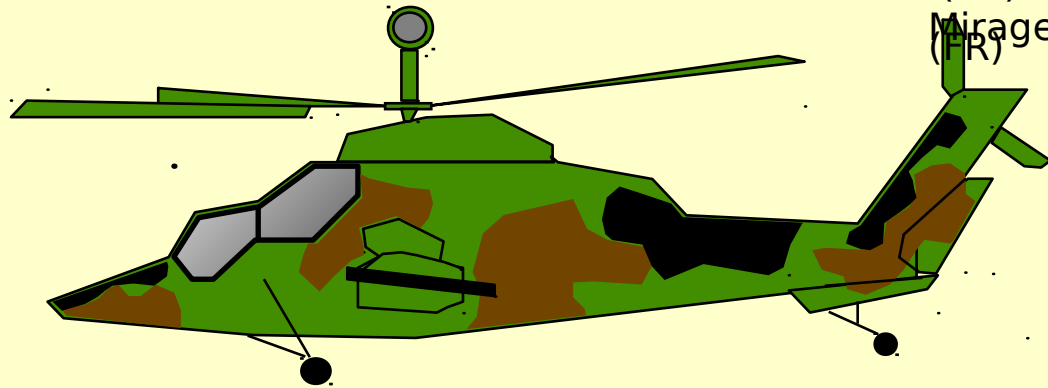
### Battle Command

- GPS / INS
- Digital data transfer
- Integrated cockpit
- “Fly by Light” controls

	UAVs	Helicopters	Fixed Wing
<b>Most Common</b>	DR-3 Drone (RS) MIRACH 100 RPW (IT)	SA-342 Gazelle (FR) MI-25 Hind (RS) BO-105 (GE)	MIG-21/F-7 Fishbed MIG-23 Flogger (RS) MIG-29 Fulcrum (RS)
<b>State of the Art</b>	Pchela-1 (Schmel-1) (RS) Harpy (IS)	KA-50 Hokum “Werewolf” (RS) PAH-2 Tiger (FR, GE) A-129 Mongoose (IT)	Mirage F-1 (FR) Su-27 Flanker (RS) MIG-31 Foxhound (RS) Mirage 2000 (FR)

### Lethality

- ATGM - tandem warhead
- Medium caliber gun
- Auto tracking
- AAM



### Survivability

- Signature reduction
  - IR plume suppression
  - RCS suppression
- Warning receivers

### RSTA:

- FLIRS widespread
- Day/night capable
- EO/MMW sensors

# Weapons Technology Trends: Air Defense

## AAA

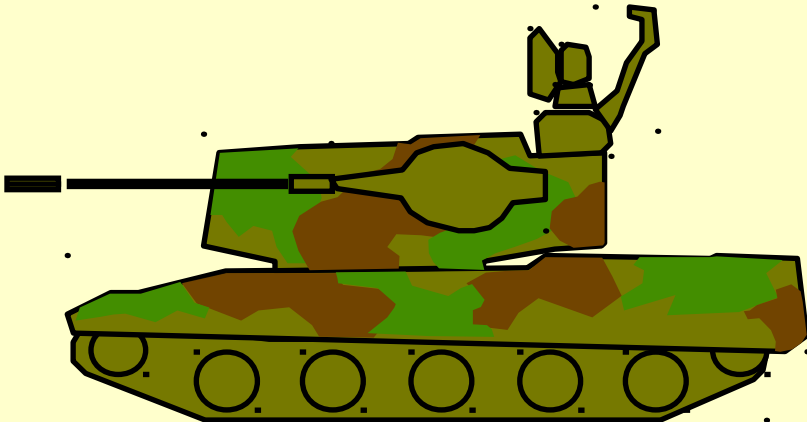
### **Munitions:**

- Course correctable
- Programmable fuze
- Improved sights
- All-weather/Day-night capability
- Dual purpose armament on IFVs

Most Common	Theater Strategic	Tactical	Manpad
	SA-2 Guideline	SA-8 Gecko	Blowpipe (UK)
	SA-3 Goa	SA-13 Gopher	SA-7 Grail
	-	ZSU 23-4	SA-14
		Crotale (FR)	Gremlin
		HAWK (US)	SA-16
		SA-15 Gauntlet	Gimlet
	SA-10 Grumble	2S6 (RS)	Stinger
	SA-12 Gladiator	Crotale NG (FR)	SA-18

## **SAMs:**

- Multiple, simultaneous engagement capability
- Range increased
- LBR guidance
- Multiple seekers
- Dual air-TBM capability





# Weapons Technology Trends: C4 & RSTA

## Tactical Targeting:

- FLIRS widespread
- Day/night capable
- Electronic scan
- Phased Array Radar
- Seismic
- MMW radar

### Communications Freq Hopping Radios

ACV 46 (SF)  
ART 2000 (IR)  
LVP 235 (IN)  
PRC- 710 (IS)  
SEM 173-193 CNR  
System (GE)

### Automated Fire Control System

Kapustnik-B (RS)  
Vivary (RS)  
AS 2000 (SF)  
BATES (UK)

## Deep Targeting:

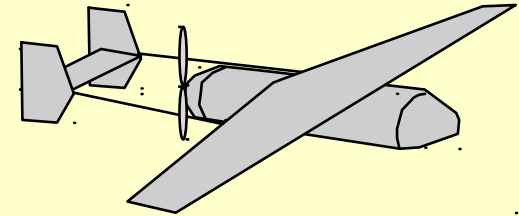
- Extended range (500-1000km) UAV
- Multi-sensor suites
- Downlink

### Communications:

- COMSAT
- Cellular telephones
- Fiber-optics
- Spread-spectrum
- Frequency hopping
- Computerized

### Satellites / Precision Navigation:

- GPS / INS
- Real time/near real time downlink -
  - Photo
  - Remote sensing
  - Data



### UAV 50 to 100KM Range

ASN-104/105 (D-4) (CH)  
Fox AT1 (FR)  
AS 2000 (SF)  
Brevel(FR/GE)  
Vulture (SF)

### UAV 100+KM Range

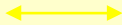
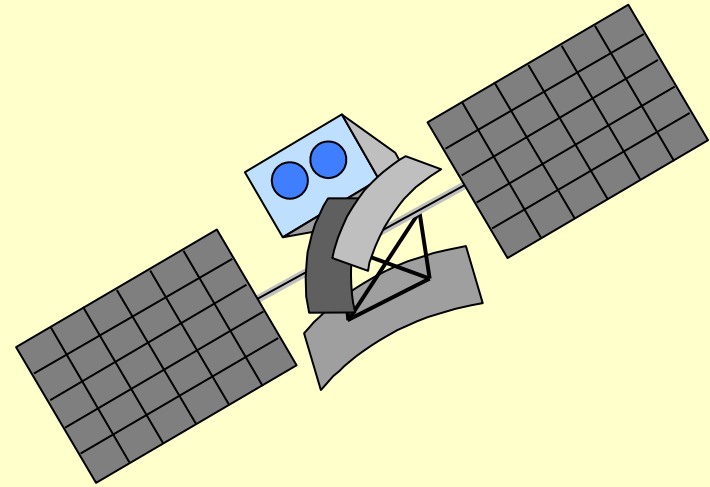
TU-143 Reys (DR-3) (RS)  
Fox AT2 (FR)  
CL-289 (CA)  
Meteor Mirach 100 (IT)  
Meteor Mirach 150 (IT)  
Scout (IS)  
Heron (IS)  
Harpy (IS)

**IMPLICATIONS:** Foreign deployed rapid sensing, target acquisition, and communication systems pose a serious threat to U.S. forces ability to function

# High Tech Challenge: Space

- **“Ultimate High Ground”**

- ◆ Recon (I & W / strategic / tactical)
- ◆ Remote Sensing
- ◆ Navigation
- ◆ Meteorological
- ◆ Communications



◆ Booster      SRBM/MRBM connection

◆ Countering space assets

- ◆ ECM (downlinks)
- ◆ Differential GPS
- ◆ Satellite prediction tools / denial programs
- ◆ Camouflage / deception
- ◆ ASAT ?

Nations / consortia with military-capable space programs						Remote Sensing
	Boosters	Recon	Comms	Nav	Met	
CIS (RS/KH)	X	X	X	X	X	
France / ESA	X	X	X		X	X
China	X	X	X		X	X
Japan	X	X	X		X	X

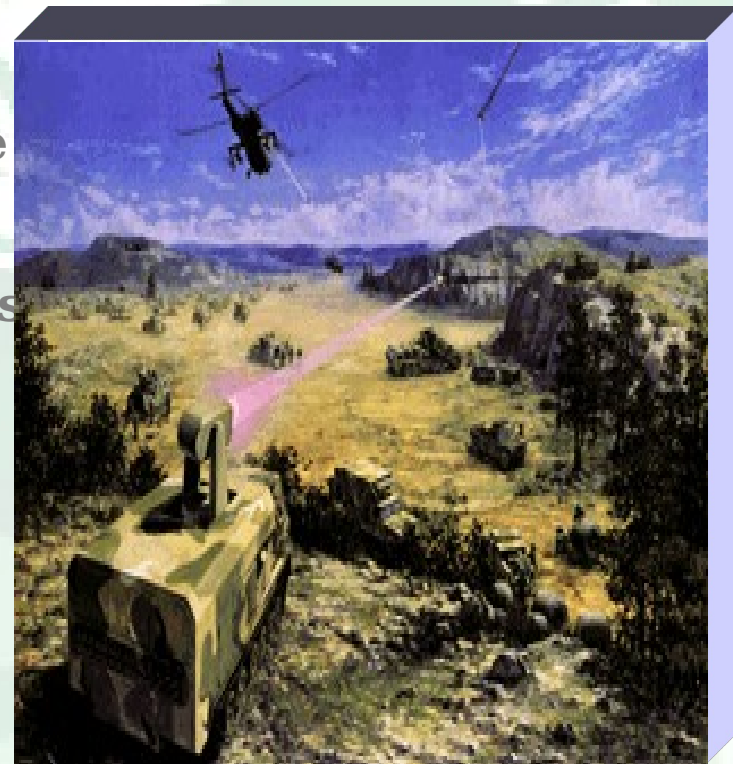
India

X

# DEW



- Lasers
- High Power Microwave
- Radio Frequency Weapons
- Particle Beam Weapons



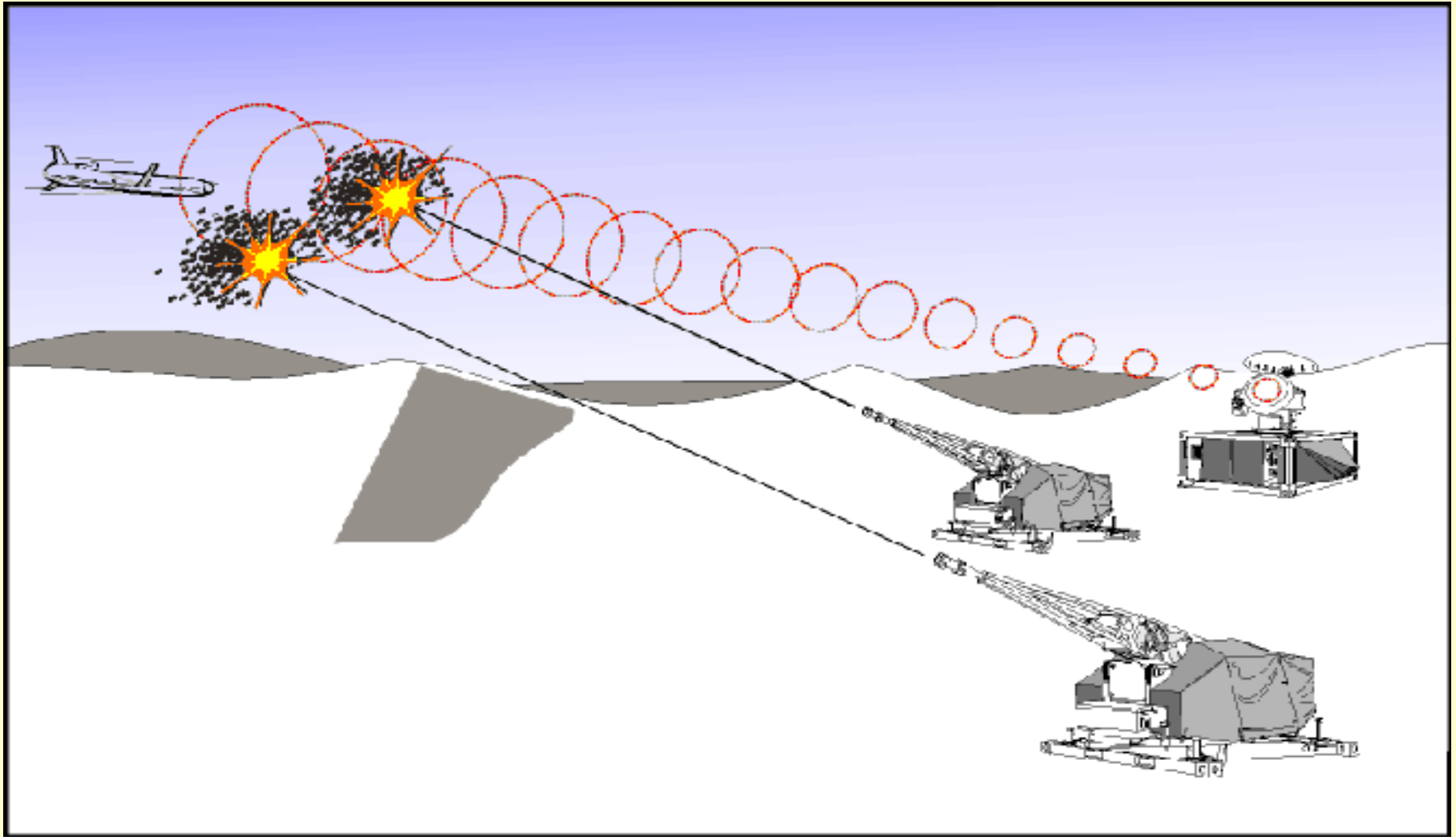
- Degrades US sensors
- Technologies are mature in China, Russia/FSU, and Europe
- “Tunable Systems” very difficult to countermeasure
- Proliferation worldwide

# SKYSHIELD Air Defense System

- Swiss twin 35 mm gun system
- Mission: defend high value fixed/semi fixed sites
- Primary targets
  - tactical fighter aircraft
  - helicopters
- Effective against
  - PGM out to 4Km
    - TLAM
    - ATGM
    - cruise missiles
- Countermeasure resistant multispectral sensors
  - radar/IR/TV
- Multisensor fire control
- On International sales market

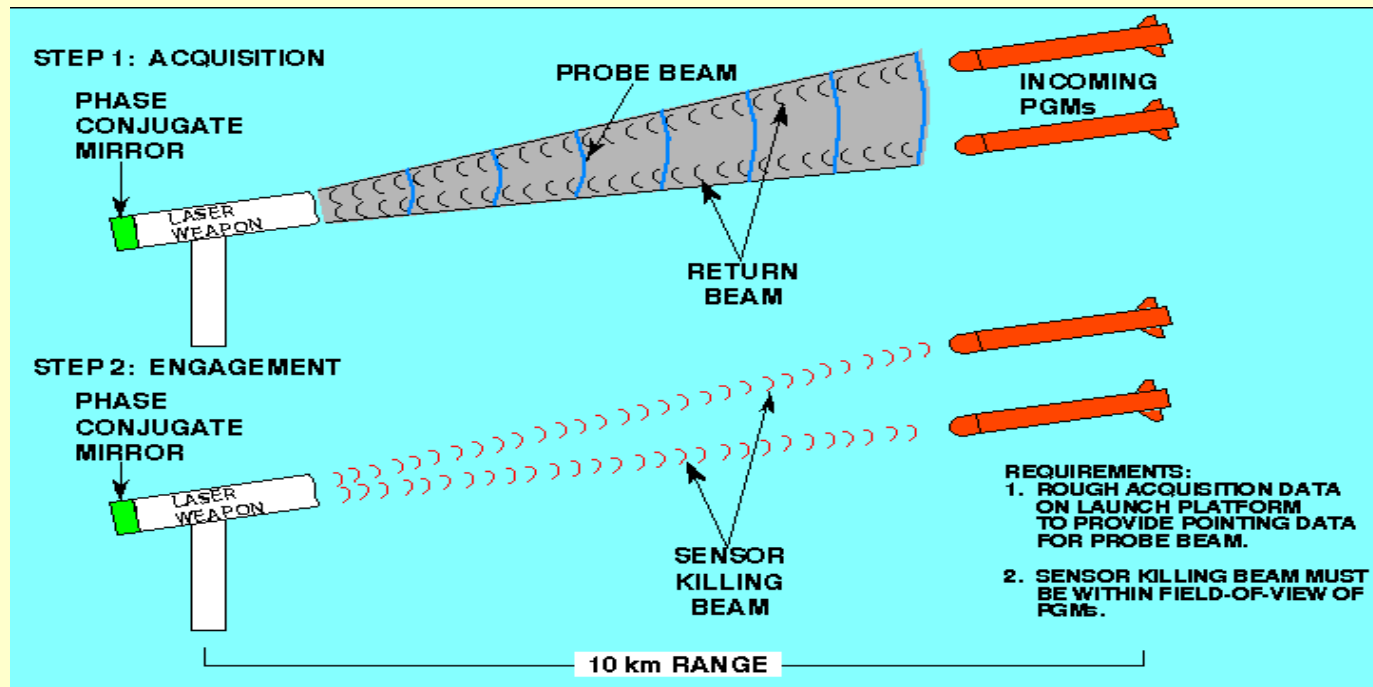


# SKYSHIELD Engaging Cruise Missile



# Directed Energy Weapons (DEW)

- Uses mirror to achieve automatic target acquisition and pointing.
  - Mirror compensates for turbulence during laser beam propagation
- Can kill RSTA sensors and ATGM-type munitions out to 10 km.



# 2S6

- Defends from low-altitude threats including fixed-wing aircraft, helicopters, remotely piloted vehicles, and cruise missiles.
- Autonomous manner or integrated within an air-defense network.
- Eight SA-19 missiles and two double-barreled 30-mm guns combined with a sophisticated electronics package on a tracked chassis.
- Maximum effective ranges of the 2S6's armaments are: 10 km for the SA-19 missile and 4 km for the 30-mm guns.
- Maximum effective altitudes are 3500 meters for the SA-19 missile and 3000 meters for the guns.
- Integrated sensor suite that consists of; an acquisition radar, a tracking radar, a 1RL138 identification friend or foe (IFF) interrogator, and an electro-optic (EO) system..





# PANTZYR-1

- Incorporates a sophisticated multispectral sensor package,
- A dual-channel fire-control system
- Engage two-targets simultaneously and have up to three missiles in flight at any time.
- Range limit for 57E6E missile is 18-km



- Counter-PGM, counter-stealth, and advanced electronic-protection capabilities
- Two 2A38 twin-barreled guns (4k range) (the same cannon used on the 2S6),
- 1400 rounds of 30-mm ammunition, and twelve surface-to-air missiles (SAM).

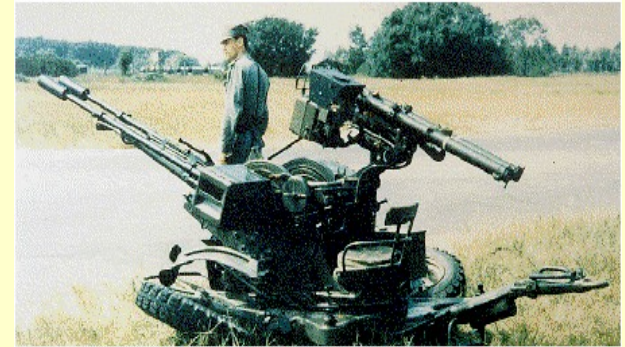
Provides protection against cruise missiles, precision-guided munitions, unmanned vehicles, fixed-wing aircraft, and helicopters



# Emerging Air Defense Systems



**Artemis-30 ADA System - Greece**



**Polish ZU-23-2-ZR - Poland**



**Chameleon ADA System - Sweden**



**Type 87 ADA System - China**



**OTOMATIC 76-mm ADA Turret -**



**ZA-35 ADA System - SA**



**SIDAM-25 ADA System - Italy**